Sustainable Blewbury

www.sustainable-blewbury.org.uk

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IN THIS NEWSLETTER

For the latest news and more information, please see our website

Sustainable Blewbury events and activities

Repair cafe

It looks as if it will be a while until we manage to hold a Repair Cafe in Blewbury. The Melland Room and the Village Hall should soon be open, and our repairers are keen to help but the Covid-19 regulations are very complicated, so it will have to wait a while.

But I (Jo) can recommend a great website called Repair What You Wear, set up by two ladies who say "***Repair What You Wear*** is our personal response to austerity and climate change … Clothes mending can save money and reduce landfill at a time that both are essential but when mending skills have all but disappeared. It is a mixture of videos and downloadable pdfs, demonstrating simple things like sewing on a button, to more complicated things like saving a jacket with an invisible repair of a seam." repairwhatyouwear.com.

JL

A Blewbury wood?

We continue to follow-up the possibility of creating a community woodland on the old sewage site at the end of the concrete path going north from the Village Hall. We are still waiting for Thames Water to confirm whether and how we can proceed, but we have taken an important step forward: the local farmer who owns the land around the site has confirmed that he is in agreement with the project going ahead. So, many thanks to Chris Kauntze; these projects have no hope of proceeding without local support. And a number of villagers have offered their help when this does move forward, so we can be confident that it will be a real community activity.

The site is actually just outside both the boundary of Blewbury Parish (strictly speaking, it's in Upton) and the AONB, so we have also been in contact with the recently started three-village HUGS (Hagbournes and Upton Group for Sustainability).

The wood will also need a new name. The Old Sewage Works is hardly descriptive of what we want to achieve. So start thinking about a new name and send us suggestions.

It is, though, quite a daunting prospect. The site is seriously overgrown with scrub and it will be hard work to establish the conditions necessary for woodland planting, especially while trying to respect the existing bird, mammal and insect life. But that is a good challenge!

John Ogden

Apple juicing

This has been an unusually good year for apples. ***If have a lot of apples, you can still hire our equipment to use at home,*** which is probably a safer Covid option. Hiring costs just £10 for 24 hours in Blewbury and Upton, £15 per day elsewhere. We provide detailed instruction sheets and advice. To book our kit, or for more information, contact Eric: **info@sustainable-blewbury.org.uk** or 07935 232 296.

We also held four successful public juicing sessions on Sunday afternoons at Blewbury Manor stable. We are grateful to Mark and Jo Blythe for their hospitality and use of the Manor Stable.

EE

Blewbury Garden Market– 11th year

We restarted our Saturday morning stall on 29th August instead of in May and continued every week through 26th September. Social distancing meant we could not use our gazebo, but fortunately the weather was kind to us. Sessions were mostly well-attended, with interesting produce and we'd like to thank our helpers and 'customers' for making it worthwhile.

EE

Annual leaf clearing

The crazy weather we are having this year is making it very difficult to decide on the best date for clearing fallen leaves from village footpaths. Sustainable Blewbury does this every year, with the help of the Parish Council and Blewbury Village Society and volunteers. All we can say at the moment is that it is likely to be on a Sunday afternoon towards the end of November, date to be decided at fairly short notice. Please watch out for a Stop Press email telling you the date and asking for your help. Bring your rakes, gloves, barrows and enthusiasm to the Play Close!

JL

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Short items and interesting links

China pledges to become carbon neutral before 2060

Although China has been installing a lot of wind and solar power, as the world's biggest user of coal and the highest greenhouse gas emitter of any country (roughly a quarter of global emissions) its pledge of setting an apparently very serious target of carbon neutrality by 2060 is a major step in limiting the effects of climate change. The pledge was made by President Xi Jinping at the United Nations General Assembly on 22 September. See a Guardian article at: tinyurl.com/yyl78m49 and a Bloomberg Green article at: tinyurl.com/yyjo79wc. Another article, at tinyurl.com/yxzedhhp , spells out why this pledge should be taken seriously:

- The announcements were made by President Xi.
- The climate targets are unilateral, and do not depend on actions by any other country.
- The climate targets are unqualified, with no pre-conditions.
- The announcements include both near- and (for the first time) long-term actions.
- The carbon neutrality target is physically meaningful on a global scale.
- The carbon neutrality target is politically meaningful, both at home and internationally.

A more down-to-earth article spelling out why China might succeed (which would be a very good thing), where other countries might fail, as well as some of the obstacles China will face, can be found at tinyurl.com/y6c8s2d3.

EE

'Lost decade for nature' as UK fails on 17 of 20 UN biodiversity targets

This article, at tinyurl.com/y3gjbr7l, summarises a report by the RSPB (downloadable from tinyurl.com/yxgr2bfy) on how poorly the UK has done in failing to honour a set of targets set in 2010 by 196 countries at the UN Convention on Biodiversity (CBD).

The UK government's own self-assessment said it failed on two-thirds of targets (14 out of 20) but the RSPB analysis suggests the reality is worse. On six of the 20 targets the UK has actually gone backwards, though the government's own assessment published last year said it was not regressing on any target.

Significant failures include insufficient funding for nature conservation, too little land being managed for nature, and declining wildlife populations. Kate Jennings, author of the RSPB report and head of site conservation policy at RSPB, said: "What we have seen is an awful lot of positive rhetoric, what we're not seeing is the action to back that up. The government creates an impression of taking this stuff seriously but as soon as you dig down into the action that's just not reflected."

In the past decade, funding for UK wildlife and the environment has dropped by 30% – the equivalent of £250M. This means habitats are not being created, protected or monitored sufficiently, the report says. On paper, the UK is protecting 28% of land and 24% of sea but in practice a lot of protected land, such as national parks and sites of special scientific interest (SSSIs), are not being properly managed. The report suggests that in reality as little as 5% of land in the UK is being effectively looked after for nature.

The government claims to be saving the country's most threatened species but the 2019 State of Nature report found 41% of UK species are declining and one in 10 is threatened with extinction. "It could not be more clear that what we're seeing is overall decline," said Jennings. "We're fundamentally dependent on nature, so God help the lot of us if we don't make serious headway in the next decade … Past performance doesn't inspire confidence." The RSPB is calling for legally binding targets to protect biodiversity. Beccy Speight, chief executive at the RSPB, said: "We cannot be in this same position in 2030 with our natural world vanishing due to inaction." The WWF's 2020 Living Planet report found global wildlife populations decreased by 68% between 1970 and 2016 with no sign of slowing.

At the next CBD in Kunming, China, in 2021, countries will agree the next 10 years of targets for nature, with many conservationists urgently calling for radical change. One of the main targets is committing to protecting 30% of land by 2030. Reaching that will mean profoundly transforming how people farm, fish, generate electricity and build houses. RSPB is launching a Revive Our World campaign to push for these targets to be made legally binding with clear milestones to monitor government progress.

EE

UK's first sea-going electric ferry launches in Plymouth

The e-Voyager is the result of a ground-breaking project designed to reduce the environmental impact of maritime transport in coastal waters. It has been developed jointly by the University of Plymouth and Plymouth Boat Trips and several other maritime firms. It will now undergo rigorous trials, including emissions assessments, and it is hoped it will carry its first 12 paying passengers in April 2021.

It uses re-purposed Nissan Leaf car batteries instead of a diesel engine – a process that could be used in other commercial vessels less than 8 m long. Plymouth City Council will install three 22 kW chargers on the Barbican Landing Stage. E-voyager will take under three hours to achieve a full charge, and when in service will be charged overnight, which provides enough energy to run for a full day, ferrying passengers across Plymouth Sound to Cornwall.

The project partners plan to progress by converting larger passenger vessels in Plymouth Boat Trips' fleet of cruise boats and ferries that operate within Plymouth Sound and also building similar vessels from scratch. There are many south-west sources for this article, but the images come from Business Live (SW): bit.ly/3nUYtLF and Plymouth University News: bit.ly/345boTL.

JL

Local air quality

The major areas of air pollution in Oxfordshire are around Oxford, Witney, Banbury and other places where rush hour traffic has to queue, for example some of the bridges over the Thames. But we should still be concerned about air pollution in Blewbury during the restrictions of the Covid 19 crisis.

This article begins with a quiz I'd like you to try, written by Oxfordshire Friends of the Earth (FOE) as part of their 2020 Action: Clean Air Day 8 October. It should make you reconsider what you know about the air pollution. Go to bit.ly/2SVm4h8 and scroll down to **The Clean Air quiz**. Download it and try it out. It was written for Oxford residents, so you probably won't know the answers to every question but try Qs 1–9 and 11. Answers are on page 3 of the quiz.

I confess that air pollution in Blewbury has never nudged climate change from the top of my agenda, and in general there are fewer cars on the road now people are going out less. But then I noticed that the number of cars parked near the village school by parents conveying their children to and from school had doubled (and many of them were SUVs). I do understand the increase in numbers, because Covid-19 rules mean that parents can only have their own children as passengers, not their children's friends. But has it affected air quality?

I attended a FOE webinar on Clean Air Day, 8 October, with talks by several interesting speakers. They were all concerned about three main constituents in car exhausts: carbon dioxide (CO_2) which is a major greenhouse gas, nitrogen oxides (gases grouped as NOx, made up of nitrogen oxide, NO, and nitrogen dioxide, NO_2, and particulates (tiny particles referred to by their size: PM2.5 means diameter less than 2.5 micrometres (*much* thinner than a human hair). These particles are found in the lungs of children living in polluted air.

The first speaker was Lynn Knapp, the headmistress of Windmill School Oxford. Her school was winner of Oxford City Council's 2020 air pollution awareness competition. She said "*At Windmill we* *teach our children about air pollution and the negative impact that polluted air has on their health. They then go home and tell their parents what they have learned, which we have found influences their parent's behaviour (less driving to school, more cycling and walking!) and we are also growing a generation of children who want to make the world a healthier place for us all.”* bit.ly/37duFEs

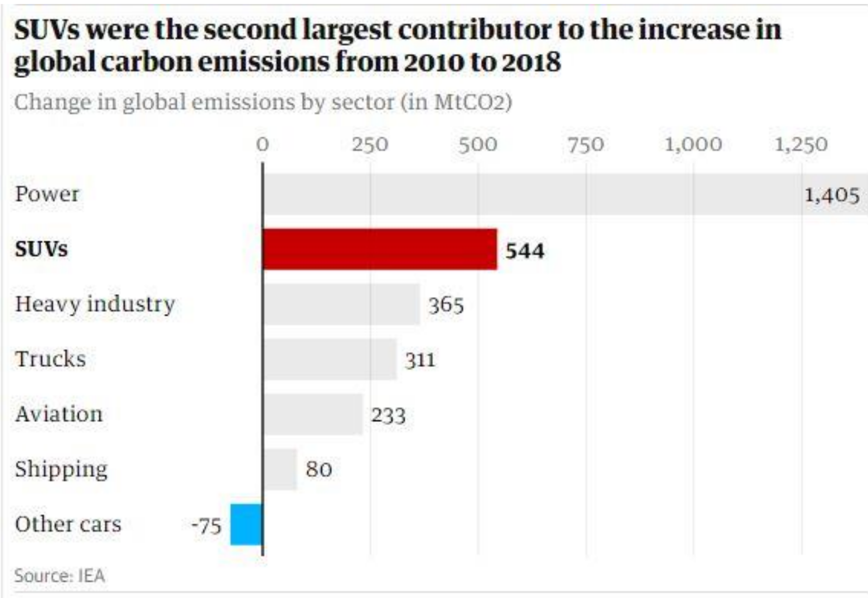
Another speaker was Dr Felix Leach, one of the leading researchers in the OxAria project, a joint project between the universities of Oxford and Birmingham: “A novel research study aimed at understanding the impacts of Covid-19 upon air and noise quality in Oxford City.” They have five air quality and noise monitors in the centre of Oxford, 12 more elsewhere in Oxford, and planned to install another at the JR hospital on Clean Air Day. An interesting early result was that although during the first few months of the pandemic NOx emissions in central Oxford had fallen by 60% the amount of particulates increased. This was also recorded elsewhere in the UK. If you think back to our spring you will remember the flooding in February and wet first part of March, which was when there was reduced travel to work. The researchers think the rise of particulates could have been due to people using their wood-burning stoves for longer, pubs and hotels now often having welcoming open fires burning, and the increase in biomass central heating systems. You can subscribe for OxAria newsletters on their website, and they also have a twitter account: twitter.com/oxaria_uk

But what about the parked cars near Blewbury School? I did not notice anyone sitting in an idling car (well done, *because an idling car emits twenty times as much pollution as one travelling at 32 mph*!).

And the growth in numbers of SUVs? I think this is best summarised below, from the Guardian of 28 October 2019:

*Figures revealed in 2018 that SUVs were the second biggest cause of the emissions rise from 2010 to 2018: “*If SUV drivers were a nation, they would rank seventh in the world for carbon emissions.”

In the period from 2010 to 2018, SUVs more than doubled their global market share of all cars sold from 17% to 39% (i.e. 4 out of 10 cars sold *globally* were SUVs!) and their annual emissions rose to more than 700 megatonnes of CO_2, more than the yearly total emissions of the UK and the Netherlands combined. (In 2018, 33% of all cars sold in Europe, including the UK, were SUVs, and in the UK they now have more than 40% of the market.)



This is not total emissions, it is the *increase* at a time when we should be *reducing* emissions. *Enough said*.

Read more in the Guardian: bit.ly/2FzoLBX and also CO2 EMISSIONS FROM CARS: the facts, a 2018 report by European Federation for Transport and Environment

FOE's advice on what we personally can do to reduce emissions can be downloaded from www.oxfoe.co.uk/what-can-we-do.

If you would like to discuss this article email me at info@sustainable-blewbury.org.uk.

Jo Lakeland

Two aspects of Oxfam

An Oxfam report, compiled together with the Stockholm Environment Institute, says the World's richest 1% cause double the CO_2 emissions of the poorest 50% (tinyurl.com/y5uejd3k).

Only a finite amount of carbon can be added to the atmosphere if we want to avoid the worst impacts of the climate crisis. *We must ensure that this carbon is used wisely.*

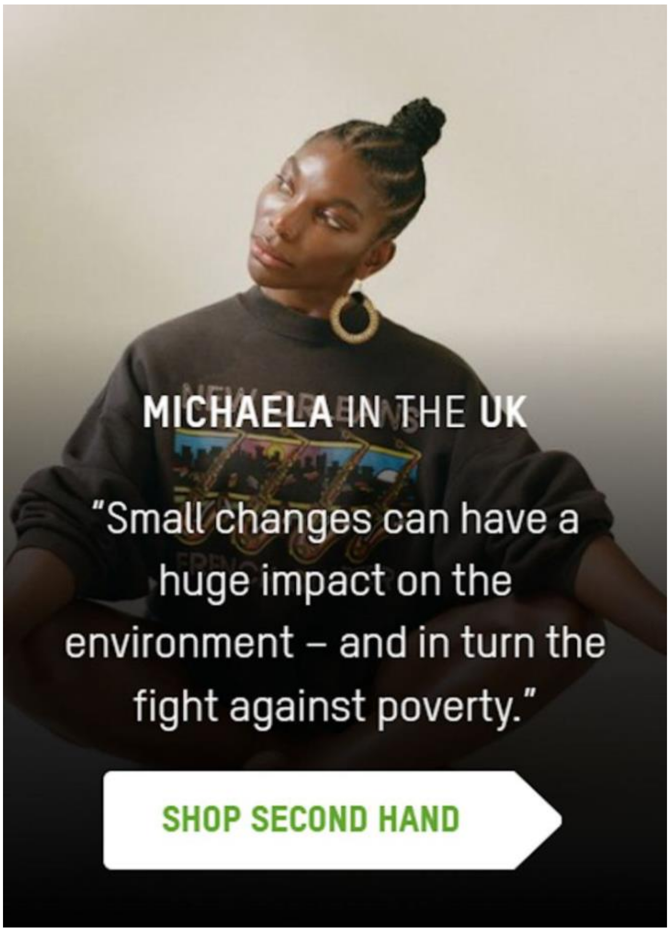
Gulfstream jet image by jemafg from pixabay

Carbon dioxide emissions rose by 60% from 1990 to 2015, but the increase in emissions from the *richest* 1% (people earning more than $100,000 per annum) was three times greater than the increase in emissions from the *poorest 50%.*

The report said that rampant overconsumption and the rich world's addiction to high-carbon transport are exhausting the world's carbon budget.

The global carbon budget has been squandered to expand the consumption of the already rich, rather than to improve the lives of billions ... We need to ensure that carbon is used for the best. Oxfam argues that continuing to allow the rich world to emit vastly more than those in poverty is unfair. The world is moving towards renewable energy and phasing out fossil fuels, but any emissions that continue to be necessary during this transition would be best used in trying to improve poor people's access to basic amenities. Read more at bit.ly/364eTLm.

What can WE do to help Oxfam fight climate change?



Oxfam is in action all over the world, fighting global poverty, the effects of the Coronavirus and climate change, so why does this post start with a picture of actress and writer Michaela Coel?

More frequent and extreme weather – such as storms and droughts – are destroying homes, and wrecking lives and livelihoods, and the world's poorest people have done the least to cause it.

There has been huge progress in the fight against poverty, but climate change threatens to reverse this progress. In fact, Oxfam believes that the climate emergency is the biggest, most urgent threat to the fight against poverty. **That's an injustice that can and must be stopped.**

You can read about what Oxfam is doing all over the world to help people affected by climate change at oxfam.org.uk. You can donate money to help, but you can also do what Michaela Coel did in her latest BBC series (I May Destroy You): all the amazing clothes she wore were second hand. She is supporting Oxfam's SAY YES TO SECOND-

HAND campaign. You can now buy second-hand clothes on their website, including designer clothes. onlineshop.oxfam.org.uk/shop/second-hand-clothes.

Wear them with pride – you are recycling as well as making a donation to Oxfam!

Jo Lakeland

Is the UK really serious about ending the use of coal?

The UK has consistently said that coal will not be used to *generate electricity* after 2024, and we have seen the use of coal to generate electricity decrease to a very low level. For example, on 10 June a record of two months of non-use of coal to generate electricity was set. As recently as 2015, on many days of the year coal contributed more than 50% of the power used by the grid. It still made up 25% of the total power mix in 2016. And gas (also of course a carbon-emitting fossil fuel) still generates a major proportion of our electricity. There's more information in this Independent article: tinyurl.com/yyfwfzad.

However, not using coal to generate electricity does not necessarily mean all use of coal is finished. See tinyurl.com/y65av27b to read that the first deep coal mine in the UK for 30 years, has just been approved in Cumbria. However, it does seem to be recognised that the new mine will have to be shut by 2049 to adhere to the UK's net-zero carbon pledge by 2050. The 2.7M tonnes of coal to be mined each year are aimed to partially offset imports of 60M tonnes of coal per year used as coking coal for processing metal, in particular steel production.

EE

'As the tundra burns, we cannot afford climate silence': a letter from the Arctic


Permafrost thaw

This is a very moving article, by Dr. Victoria Herrmann, on the extreme heating of the Arctic this year. It was circulated via a number of publications; for example, you can read it here: tinyurl.com/yydw296h.

Dr Victoria Herrmann is the president and managing director of the thearcticinstitute.org.

EE

Cambridge University to divest from fossil fuels by 2030

This article (tinyurl.com/y8nwr7pe) announces that Cambridge University is to divest its multibillion pound endowment (investment) fund from fossil fuel corporations after a five-year campaign by students, academics and politicians. This is a significant addition to the long list of bodies that have said they would stop investing in fossil fuels. Cambridge's £3.5 Bn endowment fund is one of the largest of any European university.

Serious questions will doubtless be raised about why a full decade is needed to shift money out of direct fossil fuel investments, and until 2038 to arrive at a "net-zero portfolio". Nor does there seem to be any commitment on cutting the university's close research ties with fossil fuel companies. But its message about the future of the fossil-fuel industry, combined with that of many other public bodies including Norway's $1 Tn sovereign wealth fund, means that something like a total of $11 Tn in divestment pledges have been made.

EE

'The Everest of zero carbon?'–York's green home revolution

In our newsletter of November/December 2019 we had a short item about the new Goldsmith Street social housing in Norwich, a striking development of 105 houses aiming to provide attractive living in houses built to the zero-carbon Passivhaus standard and which won architecture's Stirling Prize.

The same architects have now been chosen to design the UK's most ambitious council-led housing scheme, 600 houses on eight sites within York's ring road, all zero-carbon but designed for lower car usage and more sustainable transport (bikes, walking, etc.). Given the present lack of government funding, the council has been forced to make the developments self-sustaining, with 60% of the homes set for market sale in order to cross-subsidise 40% affordable housing, half of which will be for social rent. Some plots are also being allocated for self-build homes and a community land trust co- housing project.

"Passivhaus is like base camp when you're trying to climb the Everest of zero carbon," says architect David Mikhail. "We're planning to go above and beyond, taking into account much more than just the efficient fabric of the houses." There is more information in this article, at tinyurl.com/yyujm7k5.

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Is hydrogen a possible solution when batteries are not feasible?

by Eric Eisenhandler

'Ban new gas boilers in UK from 2025 or risk missing net-zero target, says CBI' and *`Can a hydrogen boom fuel a green recovery for Britain?*

These were the headlines on two Guardian articles (tinyurl.com/y4eo2hkv & tinyurl.com/yy4elc6m) that drew attention to something obvious: most existing and new houses in the UK have gas central heating, and most existing houses (very few of which are insulated well enough to use heat pumps efficiently) will still be in use in 2050, when the UK is due to have achieved net-zero carbon.

Switching from gas heating to a carbon-free technology is overdue and it's one of the main areas in which the UK is making insufficient progress towards the goal of not allowing gas heating boilers in new houses after 2025. A frequently mentioned replacement is hydrogen, distributed via the existing gas grid and perhaps mixed with biogas, i.e. methane from food waste. (See the item on a trial to replace some gas in the grid with hydrogen in our January/February 2020 newsletter no. 37.) Hydrogen might be used not only for heating in cases where electric heat pumps would not provide a good solution but also for transport (anything from cars through to heavy lorries, ships and aeroplanes). But switching to hydrogen isn't 'magic', and there are technical problems. In this article I'd like to mention some of the problems.

Parts of this article are taken from a page of the (now rather out of date) Blewbury Energy Initiative website, written by John Richards and me in the early days of Sustainable Blewbury, 8–10 years ago when it was less clear that electric cars would become a viable solution before hydrogen.

It now looks as if hydrogen's role might be mainly in areas where electricity based on battery storage is not practical. Hydrogen can best be regarded as an *energy storage medium*. It can either be burned as a fuel or used to generate electricity in fuel cells, supplying energy without significant greenhouse-gas emissions. Hydrogen might also be used in production of synthetic liquids to replace fossil fuels. But a necessary change is that the hydrogen *must* be produced from renewable resources, not from (as at present) fossil fuel. To achieve these goals, there are cost, safety and technical problems that must be considered, and new distribution infrastructure would probably be needed.

What are the needs?

A rapidly expanding variety of battery-driven electric cars is now available, and significant new models will very soon be on sale. As briefly mentioned in our preceding newsletter, many of the currently available electric cars are not ideally efficient due to their heavy weight and the need for a huge number of charging points to be installed, but as battery technology develops batteries will most likely become simpler and cheaper, weigh less, store more energy and hopefully require less by way of materials whose extraction is damaging to the environment, such as lithium and cobalt.

Using batteries for energy storage does not look like a viable solution for heavy lorries, long-distance buses, trains on branch lines that have not been electrified, ships and aircraft. For all of these, liquid fossil fuels are a tough act to follow, due to their convenience, portability, and relatively dense energy storage. Hydrogen can't match the properties of petroleum-based liquid fuels, but it might be a feasible alternative.

We will also need to generate electricity when wind and solar power are in short supply. Could hydrogen replace our existing gas-fuelled generators?

A very big problem in the UK is space heating. New buildings can be constructed with high standards of insulation and heated using electric heat pumps, but in 2050 most of the currently existing buildings in the UK will still be in use, and many of those buildings, currently heated by gas, might not have retrofitted insulation good enough for heat pumps to be an efficient solution. Can hydrogen have a role to play in replacing gas for heating, while using much of the existing gas grid?

Hydrogen could also replace gas for cooking, but I think for most people electric ovens and electric induction hobs might be a better way to go.

Industrial processes that use fossil fuels to produce heat might need to burn hydrogen as a fuel, where converting to electricity (from renewables) isn't feasible.

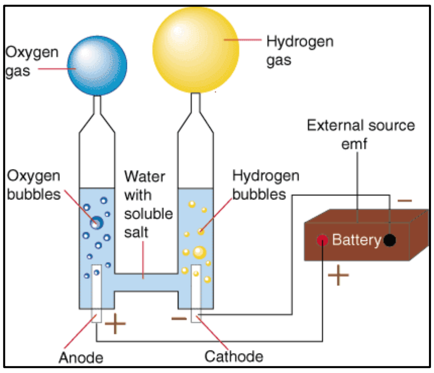
Electric aeroplanes might become feasible for short-haul routes, but for long-haul some form of sustainable fuel will be needed, ideally a liquid fuel based on hydrogen or synthesised using hydrogen. Possible alternatives include synthetic fuel made from landfill waste, e.g. by Velocys.

Introduction to hydrogen

Hydrogen is the most abundant element in the universe. It is the simplest, lightest chemical element: hydrogen atoms consist of just one proton and one electron. (Other, rarer forms of hydrogen also have one or two neutrons. Hydrogen has already been used to power space rockets, buses and cars.

A lot of the publicity gives the impression that hydrogen can simply be used as a clean energy source to replace fossil fuels, as soon as some technical problems are solved. Hydrogen might appear to be the ideal fuel: in addition to its great abundance it is non-toxic, and the residue from burning pure hydrogen is simply water. But this misses a very crucial point. Unlike fossil fuels, which already exist, hydrogen has to be produced, and that uses energy. In effect, hydrogen should really be regarded as an *energy storage medium* rather than an *energy source*. And it is crucial take account of the way it is produced, as well as how it would be distributed and used.

At present almost all hydrogen is produced from natural gas, i.e. fossil fuel. The ideal is to produce it by electrolysis, breaking water down into hydrogen and oxygen, as in the diagram, and to do so using surplus electricity from renewables such as hydropower, wind or solar energy. It could also be produced by nuclear power, and possibly in the distant future by nuclear fusion. An attractive solution is to use spare electric power from intermittent renewables when, as already happens, there is more wind or solar power available than it needed for the electricity grid.



Hydrogen production by electrolysis

Hydrogen as a fuel

Hydrogen is a very energetic fuel by *weight*, yielding around 33 kilowatt-hours per kilogram. This is two and a half to four times the energy of the same weight of conventional fuels, such as natural gas, oil or petrol. However, hydrogen has a very low molecular weight, and as a result it is a very light gas – one kilogram at atmospheric pressure occupies 11,200 litres. This means that a basic problem with hydrogen is storage.

If hydrogen is stored at atmospheric pressure, its low density means that there is only about one-third as much energy per cubic metre as in natural gas, so a gasometer holding the same energy reserves needs to be three times the volume if hydrogen is the fuel. To reduce the larger storage volume needed, hydrogen must be stored in a compressed or liquefied state, or in some sort of chemical form, and that requires energy. Hydrogen at 50 atmospheres pressure provides about 0.13 kilowatt-hours per litre. (Petrol or oil provide up to 8–10 kilowatt-hours per litre.)

Liquid hydrogen is of course denser than gaseous hydrogen, and liquid hydrogen provides 2.36 kilowatt-hours per litre but petrol at room temperature is roughly 10 times denser still, so by *volume* liquid hydrogen actually has only about one-quarter of the energy density of petrol. Liquid hydrogen must be kept *very* cold indeed; it boils at –252.8°C, only 20 degrees above absolute zero, the lowest possible temperature.

Fuel cells

(discussed below) allow the direct conversion of hydrogen's energy into electricity. This is much more efficient than simply burning the hydrogen like a conventional fuel, for example in an internal combustion engine.

How hydrogen is produced

Hydrogen is currently used in large quantities as an industrial chemical, to make ammonia for fertiliser and in processing crude oil to make fuel. Almost all of this hydrogen is produced from natural gas, oil and coal. Producing hydrogen from natural gas is fairly efficient, partly because waste heat from power stations is used in the process. However, these fossil-fuel sources are not renewable and carbon dioxide is also produced as a by-product, so this is not an acceptable solution.

Electrolysis of water, ideally using renewable energy, is currently used to produce relatively little industrial hydrogen. Often referred to as 'green hydrogen', this hydrogen is far cleaner and more sustainable.

Electric current is passed between two electrodes immersed in water. Oxygen appears at the positive electrode and hydrogen at the negative electrode. The water must be pure as impurities can damage the electrodes. The advantages of this process are that:

- it is static and simple, and so can run for long periods without attention,
- it generates very pure hydrogen, desirable for use in fuel cells, and
- the hydrogen can be generated at high pressure – this saves the considerable energy that would be required to pressurise hydrogen for ease of storage and transport.

About 80% of the electrical energy used can be stored as hydrogen. The remaining energy appears as heat, which must be removed.

Storage of hydrogen

Storage as a compressed gas

Hydrogen gas is kept under pressure to increase the storage density. Compressed hydrogen in hydrogen tanks at 350 bar (5,000 psi) and 700 bar (10,000 psi) is used for hydrogen tank systems in vehicles. Hydrogen tends to make materials brittle and susceptible to cracking, which allows hydrogen to leak out.

Storage as a liquid


Liquid hydrogen tank in a car boot

Liquid hydrogen presents more problems. An energy-intensive liquefaction process is needed to get to the required –252.8 °C, and then cryogenic storage must be used. Liquid-hydrogen storage tanks must be well insulated to minimise boil-off. Due largely to the use of liquid hydrogen fuel for space rockets, good low-mass liquid hydrogen tanks have been developed. However, they are still heavier and bulkier than petrol or oil tanks.

As a solid

Instead of storing pure hydrogen, it can also be stored as a chemical hydride or some other hydrogen-containing compound (e.g. ammonia). At the point of use the hydrogen storage material can be made to decompose, yielding hydrogen gas.

Compared with compressed hydrogen, storage as a hydride provides a higher energy density: 72 kilowatt-hours of hydrogen would need about a 20 litre lightweight container, and the hydride would weigh about 110 kg. But compared with the equivalent petrol tank, the hydride store is about three times the size and 20 times as heavy.

However, the most common method of on-board hydrogen storage in today's vehicles is still the simple option of compressed gas, at pressures of up to 700 atmospheres.

Transport of hydrogen

The low density of hydrogen also means that pipeline distribution of compressed hydrogen gas is less efficient than a similar natural gas pipeline. As mentioned above, to get the same energy as natural gas three times the volume of hydrogen must be delivered, and this uses more energy. In addition, the small, energetic molecules of hydrogen accelerate the cracking of steel (embrittlement), which increases maintenance costs, leakage rates, and material costs of tanks and pipes. Well-established pipeline installations in the USA and Germany do exist to transport hydrogen over distances of up to 40 miles. However, hydrogen pipelines are more expensive than even long-distance electricity lines.

Liquid hydrogen can be transported in standard shipping containers which include the necessary cooling and insulation. Each container holds about 40 cubic metres of liquid hydrogen. Large-scale world-wide distribution of liquid hydrogen would require ships equipped with cryogenic tanks and cooling facilities.

The problems of transport raise the important question of whether it is better to:

- use centralised renewable energy facilities to produce the hydrogen, which then needs to be distributed using infrastructure that does not yet exist, or to
- produce the hydrogen locally, which would probably be less efficient but would eliminate some of the problems and energy cost of transporting it.

Fuel cells and electricity

Combustion v. fuel cells

The low-tech option of simply burning hydrogen in place of fossil fuels could be used for a variety of applications (but electricity-producing fuel cells might often be better and more efficient):

- To heat buildings, in a similar way to natural gas. (Indeed, hydrogen was a significant component of the town gas, generated from coal, that was used before natural gas.) As mentioned in in our January/February 2020 newsletter no. 37, heating boilers could be converted to burn hydrogen, or a hydrogen/biogas mix and the existing gas grid used to distribute the fuel.

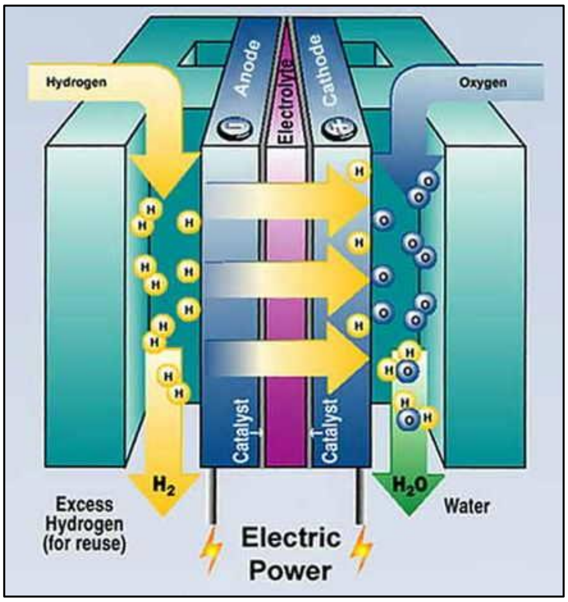
- For transport, where a portable energy supply is needed to drive lorries, buses, trains and aeroplanes. Internal-combustion engines that run on hydrogen have been available for over 60 years.

Fuel cell basics

Fuel cells provide a very efficient way of converting the energy in the hydrogen into electricity. They were first made in about 1842 by a Welsh scientist, Sir William Robert Grove, and were first used in spacecraft in the 1960s. Since 1990 there has been intensive development for commercial applications.

A *fuel cell* is an electrochemical conversion device. It produces electricity from fuel and an oxidant, which react in the presence of an electrolyte. The fuel and oxidant flow into the cell and the reaction products flow out of it, while the electrolyte remains inside. Fuel cells can operate virtually continuously as long as the necessary flows of fuel and oxidant are maintained.

The difference between fuel cells and batteries is that fuel cells must have external supplies of fuel and oxidant, e.g. hydrogen and oxygen (usually from air), whereas batteries internally store electrical energy in chemical form. Other combinations of fuel and oxidant are possible: fuels include hydrocarbons and alcohols, and oxidants include chlorine and chlorine dioxide.

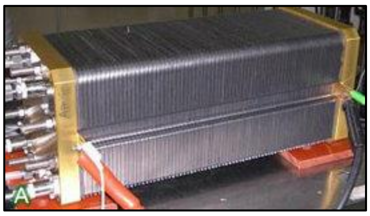


In a hydrogen fuel cell (diagram at left) the electrons and protons making up hydrogen are separated by a catalyst, typically platinum or a similar metal or alloy. The hydrogen's protons pass through an electrolyte. Its electrons, however, are forced to travel through an external circuit, thus producing electrical power. Another catalytic process takes the electrons back in, combining them with the protons and the oxidant to form water, the waste product. The diagram illustrates this. Other fuels than hydrogen produce carbon dioxide as well as water in the waste. In normal use a number of fuel cells are stacked in order to generate more electrical power.

Types of fuel cells

There are quite a few different kinds of fuel cells, with different applications. There is much more detail in [Wikipedia's fuel cell article].

Alkaline Fuel Cells were the original type used on spacecraft. They are simple and cheap to make, but they must be fed with pure hydrogen and oxygen since carbon dioxide degrades the electrolyte.



Proton Exchange Membrane Fuel Cells (PEMFC*)* are very light, very efficient, and require only atmospheric oxygen instead of pure oxygen. A membrane allows the protons through and into the electrolyte but forces the electrons to flow through the external circuit before they can combine with oxygen to form water. The photo shows a stationary stack of PEMFCs with a rated output of 5 kilowatts. *This is the favoured type of fuel cell at present for small-scale and portable applications*, but the cost is still high and needs to be reduced.

We will not list or discuss other common types of fuel cells.

Economics

Currently, fuel cells are expensive to produce, but they are becoming cheaper as new technologies and production systems develop. Fuel cells can use other materials as their energy source, but the vision is to use hydrogen. If the cost of fuel cells could be reduced to the point where some important applications can use them effectively, mass production would then drive the cost down further as new techniques are developed.

For use in cars, there are possible attractions beyond clean emissions. Fuel cells driving electric motors are lighter in weight and simpler than conventional engines. However, as noted already, hydrogen storage is a major problem, and so is the cost of making the fuel cells. At present it also takes more energy to make a hydrogen fuel cell than it produces during its lifetime.

One company claiming progress in reducing the cost and efficiency of proton exchange membrane fuel cells is **ITM Power**, which produces electrolysers to produce hydrogen locally, using renewable electricity and fuel cell. They have developed much cheaper, platinum-free membranes.

Converting to a hydrogen economy would require a lot of new infrastructure for distribution and storage, though what would be needed depends on how and where the hydrogen is generated and used. On the other hand, electric vehicles using batteries need extensive charging networks.

Safety

Hydrogen *burns* with a light blue flame which is not easy to see. To avoid people touching the flame accidentally, it is desirable to mix the hydrogen with a small proportion of a fuel such as methane to colour the flame. Burning hydrogen in air is not entirely benign, as some nitrous oxide (a potent greenhouse gas, and a damaging air pollutant) is also produced. Hydrogen may spill in accidents and then catch *fire*. This is similar to the problem with petrol. The advantage of hydrogen is that it is much lighter than air and rises, so the area affected should be limited, while petrol and oil spread across the ground spreading the fire at the same time.

Mixtures of hydrogen with air can *explode*, and if an explosive mixture is present very little energy is needed to trigger the explosion. Hydrogen has the widest explosive-ignition mixture range with air of all gases except acetylene, and because it diffuses easily its storage containers have to be sealed extremely well. A counter argument is that the same is true of natural gas and petrol vapour, yet with appropriate care we use these reasonably safely.

A possible confusion in introducing the hydrogen economy is the popular linkage of the term with the hydrogen bomb. There are, of course, no radioactivity problems in the uses of hydrogen being proposed here. *Nuclear fusion* is a totally different use of hydrogen.

Hydrogen can affect many materials it comes in contact with, including its containers, typically making them *brittle* and leading to leaks.

Hydrogen airships

During the late 1920s and 1930s, airships like the *Graf Zeppelin*, and then the larger LZ 129 *Hindenburg* operated regular transatlantic flights taking a few days each from Germany to North America and Brazil. These airships were filled with hydrogen for buoyancy but were propelled by gas-powered engines.

The *Hindenburg* disaster in 1937, when the largest of these zeppelins was destroyed within one minute, due to a hydrogen fire in New Jersey on completion of its first transatlantic crossing hastened the demise of this means of travel.

Possible environmental problems

Water vapour is a greenhouse gas

The unavoidable product of using hydrogen is water, so would water vapour from the exhausts of millions of vehicles add to global warming? In fact, the volume of water in the atmosphere created by using hydrogen would be negligible compared with that generated by natural processes.

Disposal of fuel cells

Fuel cells have a limited life, and there may be difficulties in recycling the materials from which they are made.

Outlook

Hydrogen seems fairly likely to have a role in energy supplies in the future – the question is how big a role, and what it will be.

Electricity generation

Hydrogen might be used instead of gas to provide flexibility when demand is high and sufficient renewable sources (wind and solar) are not available. This would be a limited role because producing hydrogen using electricity, transporting and storing the hydrogen, and then generating electricity from the hydrogen cannot be very efficient.

Hydrogen fuel cells might take over from batteries in providing back-up when mains power fails, or for off-grid use.

Space heating

Hydrogen might well have a role to play in providing clean heating to replace gas in older buildings that can't be easily retrofitted with sufficiently good insulation to use electric heat pumps.

Fuel for industrial processes

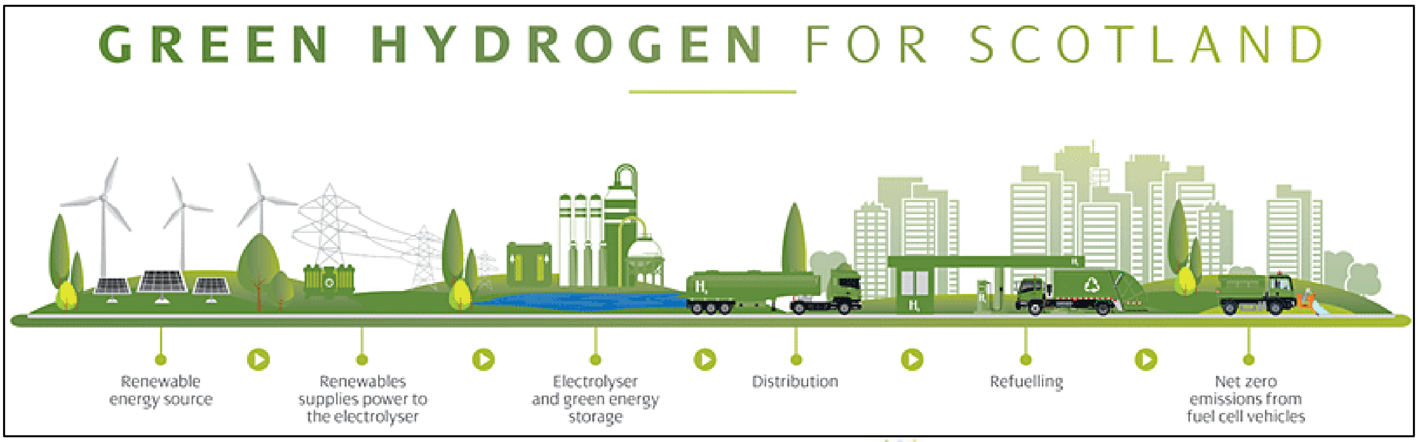
Many industrial processes (for example processing of metals), require high temperatures. A clean fuel source is needed, and hydrogen may well be the solution in place of such fuels as oil and gas.

Transport

At present, the solution for cars seems to be batteries and electricity. Lorries, buses, ships and trains on non-electrified branch lines could be where hydrogen might provide a clean solution using fuel cells. For aeroplanes, batteries seem to be too heavy so hydrogen might be at least part of a green solution, along with alternative fuels such as that being developed by Velocycs.

Producing green hydrogen

Scottish Power has announced a programme to produce hydrogen using renewable electricity (from wind and solar) to produce hydrogen for fuelling heavy vehicles, initially in Glasgow. There is more about this on their website, at: tinyurl.com/y4uafzde.



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Liquid fossil-fuel replacement

As well as being used directly as a fuel, UK-sourced biomass or stored carbon dioxide (either extracted from the atmosphere or sequestered carbon emissions) might be combined with hydrogen made using surplus renewable electricity to manufacture carbon neutral synthetic gas and liquid fuels

Ammonia

A possible alternative to hydrogen, or a more convenient way to transport hydrogen, is to use carbon-free ammonia (NH_4). It might even be used to power ships. The normal way to produce ammonia, the Bosch–Haber Process, emits a lot of carbon, but there are newer alternatives. To learn more about ammonia, there's a short summary from the Royal Society here, an interesting article at tinyurl.com/y3262s6p and a longer article from Science magazine, at tinyurl.com/y8qucr7d.

Summary

The author Chris Goodall has written a short article (tinyurl.com/y4gubt95) summarising nine areas in which the UK has to work in order to be able to achieve net-zero carbon emissions. To quote one of his sections, on hydrogen:

"Under the scenario described above [i.e. large quantities of renewables, generating electricity], we will have far too much electricity almost all the time. Batteries can cope with some of this surplus but most of the power should be converted to hydrogen. Today, hydrogen is created from fossil fuels, but it can be easily made from water using electrolysis. The gas can then be stored to make electricity on the rare occasions when the available renewable power is insufficient. Hydrogen is hugely versatile; it can also be deployed to power vehicles, to provide the energy for steel-making and other industrial processes, and to act as the critical raw material for the chemicals industry.

"In the last few months, major European countries have shifted strongly towards this plan. France and Germany have promised a total of €16 Bn to help build a hydrogen sector. Companies in Norway and Denmark have announced plans to create chemical plants to build zero-carbon liquid fuels made from hydrogen and using carbon dioxide captured directly from industrial processes. Italy's dominant gas distributor has begun mixing hydrogen into its pipelines while Spain's largest utility company is to build a facility to make the gas from solar electricity and use it to provide all the needs of a large fertiliser plant. Shell plans to take surplus electricity from North Sea windfarms to provide hydrogen for an oil refinery in the Netherlands. A Finnish partnership has suggested using the CO_2 from paper mills to combine with green hydrogen to make substitutes for petrol and diesel while a French mill will be using it to make electricity when power prices are high. All this has happened in the last year and the number of announcements is speeding up across the continent."

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Hydrogen cars and other transport

by Eric Eisenhandler

Cars

As we mentioned briefly in our previous newsletter, many of the electric cars currently on sale are not ideal low-energy vehicles due to their size and very heavy weight. A future for wider use of hydrogen fuel-cell-powered cars is not yet totally excluded. Many of the main car manufacturers have produced prototype hydrogen-fuelled cars. A list can be found **here**. However, most of these were one-off demonstration models. The big advantage, compared to battery electric cars, is that they can be refuelled in a few minutes at a relatively conventional filling station. Japan, in particular, has been investing in hydrogen fuel-cell vehicles rather than electric ones.

Some, such as the ***BMW Hydrogen 7*** (100 produced) used internal combustion engines – the BMW could burn petrol as well as hydrogen, stored in liquid form. Most others use fuel cells fed by compressed hydrogen to drive electric motors. However, fuel cells are much more efficient and thus allow the cars to have longer ranges than cars burning the hydrogen conventionally.

The first hydrogen car to go into small-scale production beyond the level of a few prototypes was the ***Honda Clarity***, with a range of well over 300 miles. The hydrogen-powered ***Hyundai Nexo*** (based on the ix35 model) was released in early 2019. It claims a range of over 400 miles. Hyundai is working with Transport for London, ITM Power, Air Products and Johnson Matthey to develop more hydrogen filling stations in the UK, including outside London (which has about half a dozen).

Hyundai Nexo

Second generation (2020) Toyota Mirai

The ***Toyota Mirai*** is the first mass-produced hydrogen car, with most sold in Japan and the US but only a few in Europe, including the UK. Its high price (about £65,000) and the lack of hydrogen filling stations means it's not a practical choice for most people.

Taxis

In 2010 a prototype London taxi, powered by hydrogen fuel cells charging lithium-ion batteries and built by Lotus, was shown. A fleet of five hydrogen taxis was in operation for the Olympics in 2012 and continued until 2015. Currently a London firm, Green Tomato Cars, has a fleet of Toyota Mirai taxis, and their range of over 300 miles usually exceeds their daily journeys. The firm added 50 more of these at the end of 2019. Toyota claims that each of the first batch of 27 vehicles have saved four times their own weight in CO_2 and by then they had covered more than a million miles.

Hydrogen buses (London)

An interesting summary of green buses in London may be found at tinyurl.com/y6enp4bl. In central London, all double-deck buses are hybrid as of 2019 and all single-deck buses will have zero exhaust emissions by this year. By 2037 at the latest, all 9200 buses across London will be zero emission. Eight routes (four in central London) are using electric buses.

Eight prototype hydrogen buses (route RV1) were introduced starting in Dec. 2010, and some of these are still being used on route 444. The world's first hydrogen double-deck buses will be introduced on three London bus routes next year.

A hydrogen fuel-cell-powered train

A hydrogen fuel-cell powered local train being trialled in Warwickshire was recently in the news. See: bbc.co.uk/news/av/business-54350046. It is mainly aimed at use on branch lines that have not been expensively electrified.

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The Sustainable Blewbury newsletter is produced and edited by Jo Lakeland and Eric Eisenhandler

In more normal times we have a wide-ranging programme of activities in and around the village. Participating is fun and can make a positive contribution to village life and the local environment. If you'd like to get involved, or to receive our free bimonthly Newsletter, email us at info@sustainable-blewbury.org.uk or phone John at 01235 850372 or Jo at 01235 850490.